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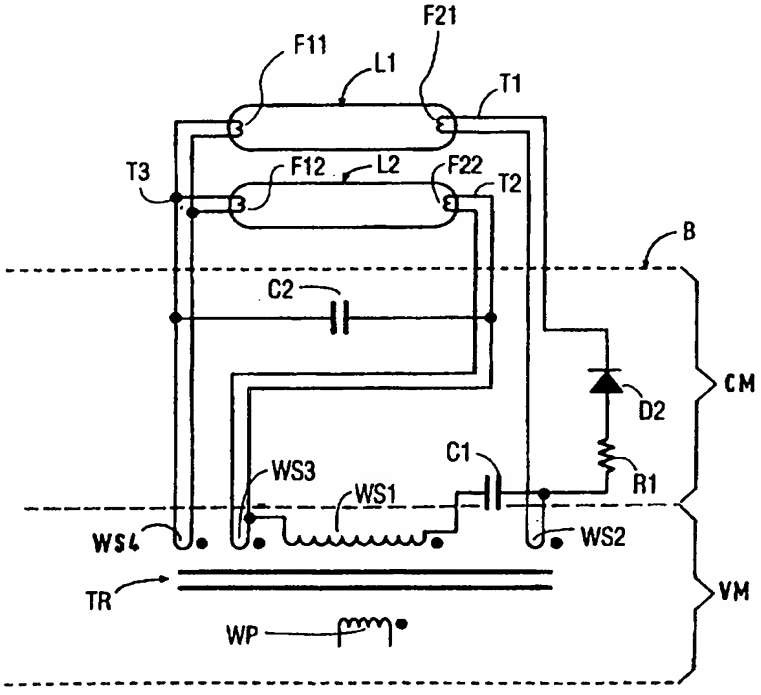
(54) Title: ELECTRIC SUPPLY FOR A LOW PRESSURE DISCHARGE LAMP

(57) Abstract

The present invention relates to a circuit (B) for operating lamp means comprising one or more low pressure discharge lamps (L1, L2) having electrodes formed by filaments (F11, F21, F12, F22). The circuit comprises: voltage developing means (VM) for developing an operating supply voltage and a filament supply voltage each of which alternate in polarity at a same frequency; and coupling means (CM) for coupling the operating supply voltage between a terminal (T1) of one of said filaments (F21) of said lamp means and a terminal (T2) of another of said filaments (F22) of said lamp means and for coupling the filament supply voltage across each of said filaments. The coupling means (CM) are configured to produce a voltage across at least one of said filaments which voltage has an asymmetry between its opposite polarities.



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Electric supply for a low pressure discharge lamp.

The present invention relates to a circuit for operating lamp means comprising one or more low pressure discharge lamps having electrodes formed by filaments, said circuit comprising:

voltage developing means for developing an operating supply voltage and a filament supply voltage each of which alternate in polarity at a same frequency; and

coupling means for coupling the operating supply voltage between a terminal of one of said filaments of said lamp means and a terminal of another of said filaments of said lamp means and for coupling the filament supply voltage across each of said filaments.

Such a circuit is known from USP 5,369,339. Low-pressure discharge lamps, such as fluorescent lamps, are generally operated with a voltage that alternates in polarity at a high frequency (usually more than 20 KHz) applied between electrodes constituted by filaments at opposite ends of the lamp producing an AC lamp current. When so operated, so called "striations" in the plasma of the lamp may appear as a pattern of alternating comparatively light and comparatively dark regions, which pattern may move longitudinally. As described in the aforementioned patent, circuitry for producing a DC component in lamp current or voltage, or an asymmetry between amplitudes of opposite polarities thereof, is utilized to reduce the occurrence of such striations or their visibility. Typically, the anti-striation circuitry causes the striations to move so fast that the plasma appears to an observer to be producing a uniform illumination.

A known anti-striation circuit utilizes a series combination of a diode and resistor (or resistor combination) in series with the lamp. Because anti-striation circuitry of this type is across a lamp voltage, relatively high voltage components are required therefor, which adds expense to manufacture the lamp operation circuitry within, for example, an electronic ballast.

It is an object of the present invention to produce a circuit for operating

lamp means which reduces striations with relatively inexpensive low voltage components. According to the present invention, the circuit is characterised in that, the said coupling means are configured to produce a voltage having an asymmetry between its opposite polarities across at least one of said filaments.

The present invention is based upon the discovery that striations can be reduced by producing an asymmetry in filament voltage rather than in the applied lamp voltage. Consequently, it is no longer necessary to produce an asymmetry between the opposite polarities of the lamp operating voltage applied between the opposite filaments of a lamp or series combination of lamps. Because the filaments are operated at a relatively low voltage compared to the voltage between the lamp electrodes, low power components may be used to produce the asymmetry resulting in manufacturing cost savings. For example, low cost carbon film resistors may be used rather than the more expensive metal glaze high voltage resistors.

A practical embodiment of the present invention is characterised in that, said voltage developing means comprises a transformer having a first secondary winding across which said operating supply voltage is developed, a second secondary winding across which said filament supply voltage is developed for one of said filaments and a third secondary winding across which said filament supply voltage is developed for another of said filaments.

A particular embodiment of the present invention is characterised in that, said coupling means are configured to produce a half-wave rectified voltage across said at least one of said filaments of said lamp means. As a result the said filament is supplied with a unidirectional current which flows during one polarity of the high frequency lamp voltage. To compensate for the fact that the filament current flows one half of the time, the voltage driving the filament may be increased in amplitude relative to the filament driving voltage in prior art filament supply circuitry.

Preferably, the coupling means are configured to produce a half-wave rectified voltage across each of said filaments of said lamp means.

Advantageously, the half-wave rectified voltages applied to the filaments are in phase with each other, i.e. the unidirectional currents flow in the two different filaments in the same half cycles of the high frequency lamp voltage.

An embodiment of the present invention is characterised in that, the lamp means comprise a first and a second low pressure discharge lamp, and in that the coupling means comprise

first coupling means for coupling the first filaments of the lamps into a parallel combination, the second filaments of the lamps thereby constituting opposite electrodes of a series combination of said lamps;

second coupling means for coupling the operating supply voltage between a terminal of the second filament of one of said pair of lamps and a terminal of the second filament of the other of said pair of lamps, and for coupling the filament supply voltage supply across said parallel combination of first filaments and across the respective second filaments of said pair of lamps;

wherein, said second coupling means are configured to produce a half-wave rectified voltage across at least one of the second filament of the first lamp, the second filament of the second lamp and the parallel combination of first filaments. In this embodiment the lamps are effectively connected into a series combination whose opposite electrodes are constituted by second filaments of the lamps.

A practical embodiment of this embodiment, is characterised in that, the voltage developing means comprises a transformer having first secondary winding across which said operating voltage supply is developed, a second secondary winding across which said filament supply voltage is generated for the second filament of one of said lamps a third secondary winding across which said filament supply voltage is developed for the second filament of the other of said lamps and a second secondary winding across which said filament supply voltage is generated for said parallel combination of first filaments.

Preferably the second coupling means are configured to produce a half-wave rectified voltage across each of said second filaments the voltages across the respective second filaments being in phase with each other.

In an alternative embodiment said second coupling means are configured to produce a half-wave rectified voltage across said parallel combination of first filaments.

Other objects, features and advantages of the present invention will become apparent upon perusal of the following detailed description when taken in conjunction with the appended drawing. Therein:

Figure 1 is a schematic diagram of a circuit for operating a combination of two fluorescent lamps including an anti-striation circuit in accordance with the prior art; and

Figures 2, 3 and 4 are schematic diagrams of circuits for operating a

combination of two fluorescent lamps including an anti-striation circuit in accordance with different embodiments of the present invention.

Referring first to Figure 1 of the drawing, there is shown a prior art circuit for operating a pair of low-pressure discharge lamps L1, L2, here fluorescent lamps, in a manner to reduce the occurrence or visibility of striations. In particular, when lamps L1, L2 are 36W krypton lamps (model 36W54T8), objectionable striations appear a few minutes after starting, in the absence of anti-striation circuitry. A first filament F11 of lamp L1 and a first filament F12 of lamp L2 are connected in parallel. The second filament F21 of lamp L1 and the second filament F22 of lamp L2 constitute opposite electrodes of a series combination of lamps L1, L2.

The lamp operating circuit is an electronic ballast B comprising voltage developing means VM and coupling means CM. The voltage developing means VM receive AC line voltage L and convert that voltage to a voltage of alternating polarity at a high frequency above the range of audibility of sound and below the AM radio band, for example about 60 KHz. This is accomplished by first converting the AC line voltage to DC in a full wave rectifier bridge R, and applying the DC output therefrom to an oscillator or inverter I, whose high frequency output feeds the primary winding WP of a transformer TR. The transformer TR has a first secondary winding WS1 across which an operating supply voltage is developed, and second, third and fourth secondary windings WS2, WS3, WS4 across which filament supply voltages are developed for filaments F21, F22, and the parallel combination of F11, F12, respectively. Typically, the first secondary winding WS1 has in excess of 100 turns (e.g. 146) and develops an operating supply voltage in excess of 500 V peak (e.g. 550 V) and the second, third and fourth secondary windings WS2, WS3, WS4 each have one turn and develop a filament supply voltage in the range of 3 to 5 V (e.g. 3.75 V). The number of turns of the primary winding WP depends on the voltage produced by the inverter I.

The coupling means CM couple the operating supply voltage between a terminal T1 of one of said filaments F21 of said lamp means and a terminal T2 of another of said filaments F22 of said lamp means and couple the filament supply voltage across each of the filaments. The developed operating supply voltage is coupled between terminal T1 of filament F21 and terminal T2 of filament F22 via a coupling capacitor C1. Further, to facilitate starting, a capacitor C2 is provided between terminal T2 of filament F22 and

terminal T3 of filament F12 of lamp L2.

In this prior art circuit, an anti-striation circuit is included in the form of a series combination of a diode D1 and two equal metal glaze resistors R1a and R1b connected in parallel with coupling capacitor C1. The two series resistors R1a, R1b are used because one resistor would not be sufficient to carry the peak operating supply voltage in excess of 500 volts. This anti-striation circuit, which appears in series with the series combination of lamps L1, L2, forces the voltage across each lamp to have an asymmetry in amplitude between opposite polarities. Further, in view of its location, diode D1 must be a high voltage diode.

In accordance with the present invention two high voltage resistors are no longer required. The anti-striation function may be produced by relatively low voltage components in series with one or more filaments which produce an asymmetry in voltage across the one or more filaments.

Referring now to Figure 2, there is shown a lamp operating circuit including a ballast B in accordance with a first embodiment of the present invention. While, the theory why the asymmetrical filament voltage has an anti-striation effect is presently unknown, it has been determined experimentally that this first embodiment eliminates visible striations in 36W Krypton lamps with the minimum cost of components for the anti-striation function. Therein, relative to prior art Figure 1, the diode D1 and resistors R1a, R1b are eliminated. Instead the coupling means comprise unidirectional means formed by a diode D2 in series with secondary winding WS2 to half-wave rectify the filament voltage applied to filament F21. The coupling means therewith produce a voltage having an asymmetry between its opposite polarities across said filament F21. To compensate for reduction in power due to the half-wave rectification, the amplitude of the filament supply voltage is doubled by making secondary winding WS2 two turns rather than one turn. Further, a resistor R2, forming resistive means, is placed in series with diode D2 to limit the initial filament current. Good results over a large range of input voltage were obtained with D2 being a 1A diode and R2 being a 3.3Ω, 2W carbon film resistor. This produces an RMS current in filament F21 of 370 mA.

In the embodiment of Figure 3, in addition to the secondary winding WS2 being coupled to filament F21 via the series combination of diode D2 and resistor R2 as in the embodiment of Figure 2, secondary winding WS3 is coupled to filament F22 via the series combination of diode D3 and resistor R3 and secondary winding WS4 is coupled to the parallel combination of filaments F11 and F12 via the series combination of diode D4 and

resistor R4. Therein, the diodes D2, D3 and D4 are located and oriented and the various secondary windings having a polarity such that unidirectional currents are applied to the filaments F11, F21, F12 and F22 in the same half cycles. In other words, the half-wave rectified voltages applied to each filament are in phase with each other. Good results are obtainable with the secondary windings WS2, WS3 and WS4 made two turns, diodes D2, D3 being 1A, diode D4 being 2A, (or two 1A diodes in parallel) and resistors R2, R3 being 3.3Ω, 2W, and resistor R4 being 1.5Ω, 0.5W.

Figure 4 shows a further embodiment of the invention wherein only the voltage across the parallel combination of filaments F11, F12 is unidirectional. Therein, diode D4 and resistor R4 are in series with secondary winding WS4. As in the embodiment of Figure 3, winding WS4 is made two turns, D4 is a 2A diode (or two 1A diodes in parallel), and R4 is a 1.5Ω, 0.5W carbon film resistor.

CLAIMS:

1. A circuit (B) for operating lamp means comprising one or more low pressure discharge lamps (L1, L2) having electrodes formed by filaments (F11, F21, F12, F22), said circuit comprising:

voltage developing means (VM) for developing an operating supply voltage and a filament supply voltage each of which alternate in polarity at a same frequency; and

coupling means (CM) for coupling the operating supply voltage between a terminal (T1) of one of said filaments (F21) of said lamp means and a terminal (T2) of another of said filaments (F22) of said lamp means and for coupling the filament supply voltage across each of said filaments;

characterised in that, said coupling means (CM) are configured to produce a voltage having an asymmetry between its opposite polarities across at least one of said filaments.

2. A circuit as claimed in Claim 1, characterised in that, said voltage developing means (VM) comprises a transformer (TR) having a first secondary winding (WS1) across which said operating supply voltage is developed, a second secondary winding (WS2) across which said filament supply voltage is developed for one of said filaments (F21), and a third secondary winding (WS3) across which said filament supply voltage is developed for another of said filaments (F22).

3. A circuit as claimed in Claim 1 or 2, characterised in that, said coupling means (CM) is configured to produce a half-wave rectified voltage across said at least one of said filaments (F21) of said lamp means.

4. A circuit as claimed in Claim 1 or 2, characterised in that, said coupling means (CM) is configured to produce a half-wave rectified voltage across each of said filaments (F11, F12, F21, F22) of said lamp means.

5. A circuit as claimed in Claim 4, characterised in that, the voltages across the respective filaments (F11, F12, F21, F22) are in phase with each other.

6. A circuit as claimed in claim 1, characterised in that, the lamp means comprise a first and a second low pressure discharge lamp (L1, L2), and in that the coupling means (CM) comprise

first coupling means for coupling the first filaments (F11, F12) of the lamps into a parallel combination, the second filaments (F21, F22) of the lamps thereby constituting opposite electrodes of a series combination of said lamps;

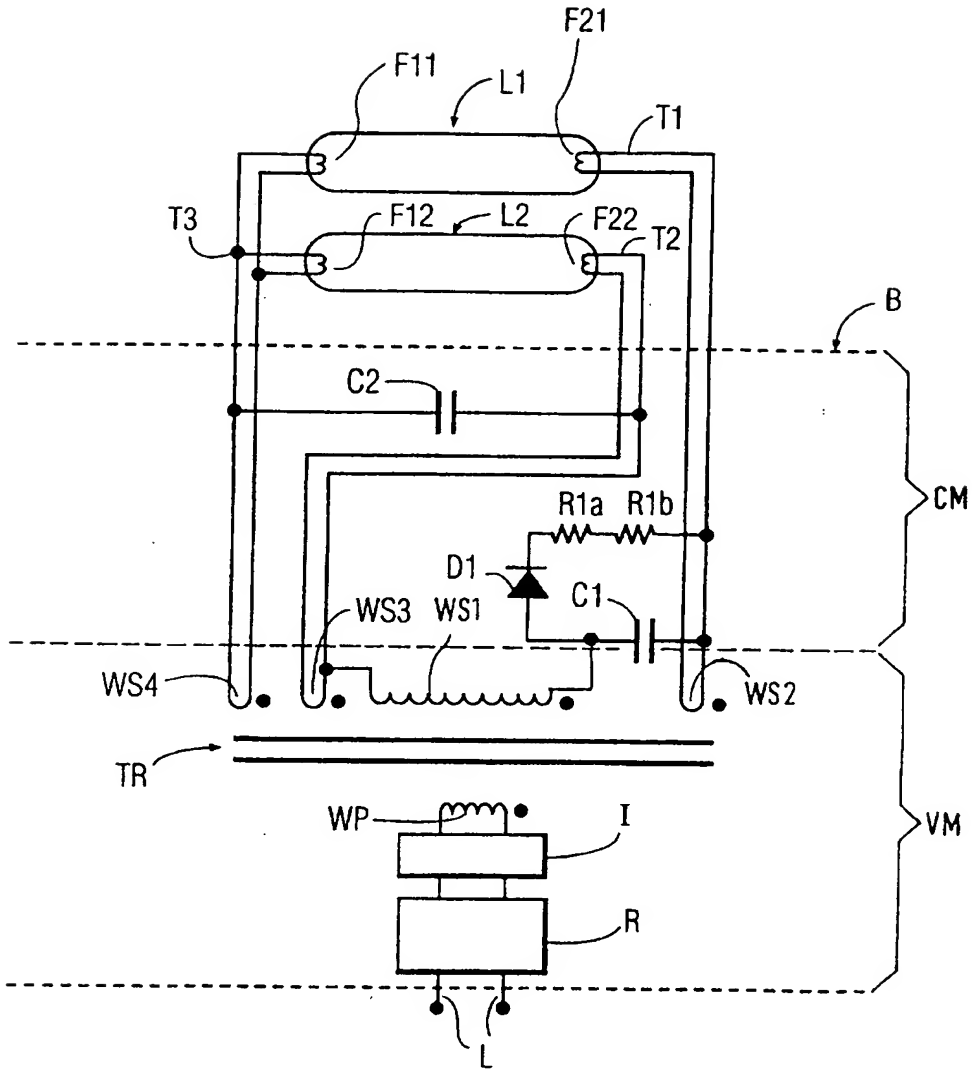
second coupling means for coupling the operating supply voltage between a terminal (T1) of the second filament (F21) of one (L1) of said pair of lamps and a terminal (T2) of the second filament (F22) of the other (L2) of said pair of lamps, and for coupling the filament supply voltage supply across said parallel combination of first filaments (F11, F12) and across the respective second filaments (F21, F22) of said pair of lamps;

wherein, said second coupling means are configured to produce a half-wave rectified voltage across at least one of the second filament (F21) of the first lamp (L1), the second filament (F22) of the second lamp (L2) and the parallel combination of first filaments (F11, F12).

7. A circuit as claimed in Claim 6, characterised in that, said voltage developing means (VM) comprises a transformer (TR) having first secondary winding (WS1) across which said operating voltage supply is developed, a second secondary winding (WS2) across which said filament supply voltage is generated for the second filament (F21) of one of said lamps (L1), a third secondary winding (WS3) across which said filament supply voltage is developed for the second filament (F22) of the other of said lamps (L2), and a second secondary winding (WS4) across which said filament supply voltage is generated for said parallel combination of first filaments (F11, F12).

8. A circuit as claimed in Claim 6 or 7, characterised in that, said second coupling means (CM) is configured to produce a half-wave rectified voltage across each of said second filaments (F21, F22), the voltages across the respective second filaments being in phase with each other.

9. A circuit as claimed in Claim 6, characterised in that, said second coupling means is configured to produce a half-wave rectified voltage across said parallel combination of first filaments (F11, F12).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F11
L1
T1
T3
F12
L2
F22
T2
B
C2
CM
R1a
R1b
D1
C1
WS3
WS1
WS4
WS2
TR
WP
I
VM
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L

FIG. 1

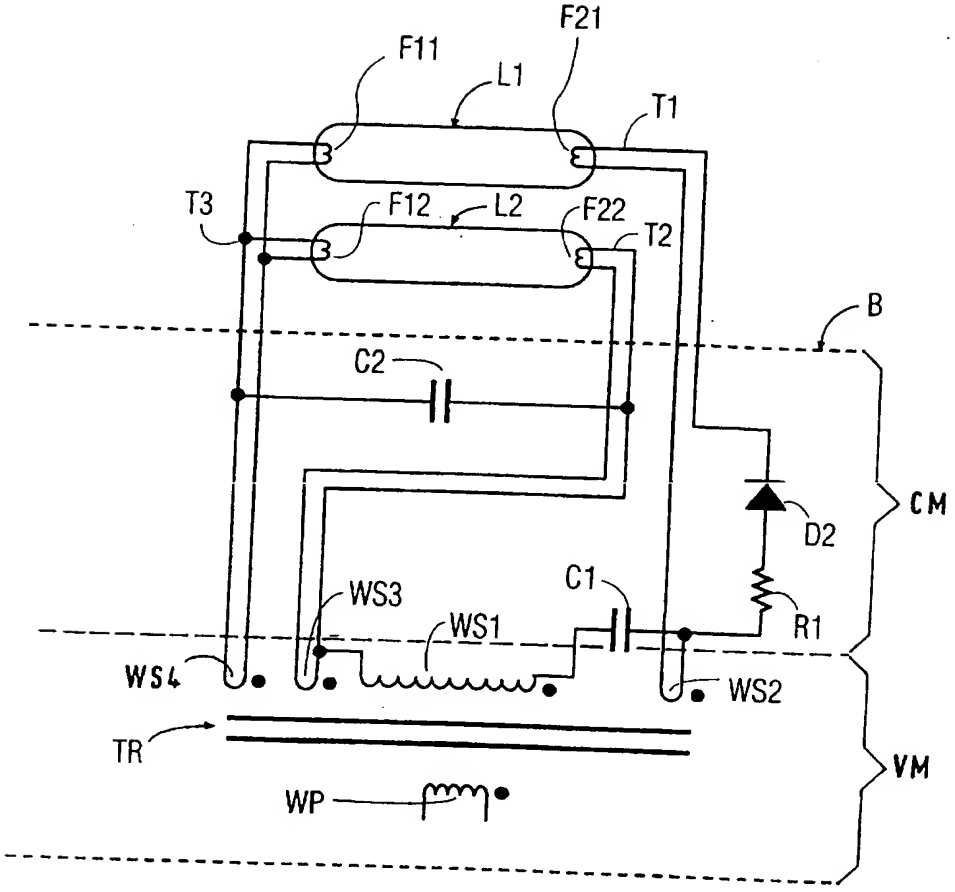
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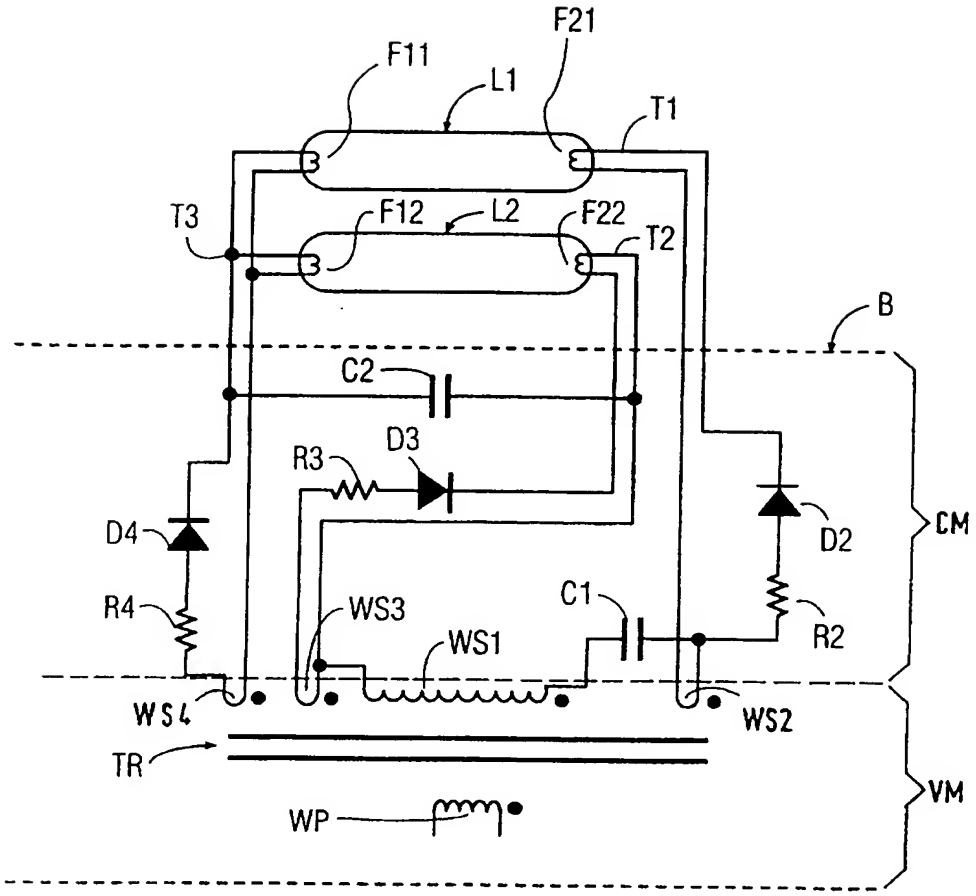
FIG. 2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WS2
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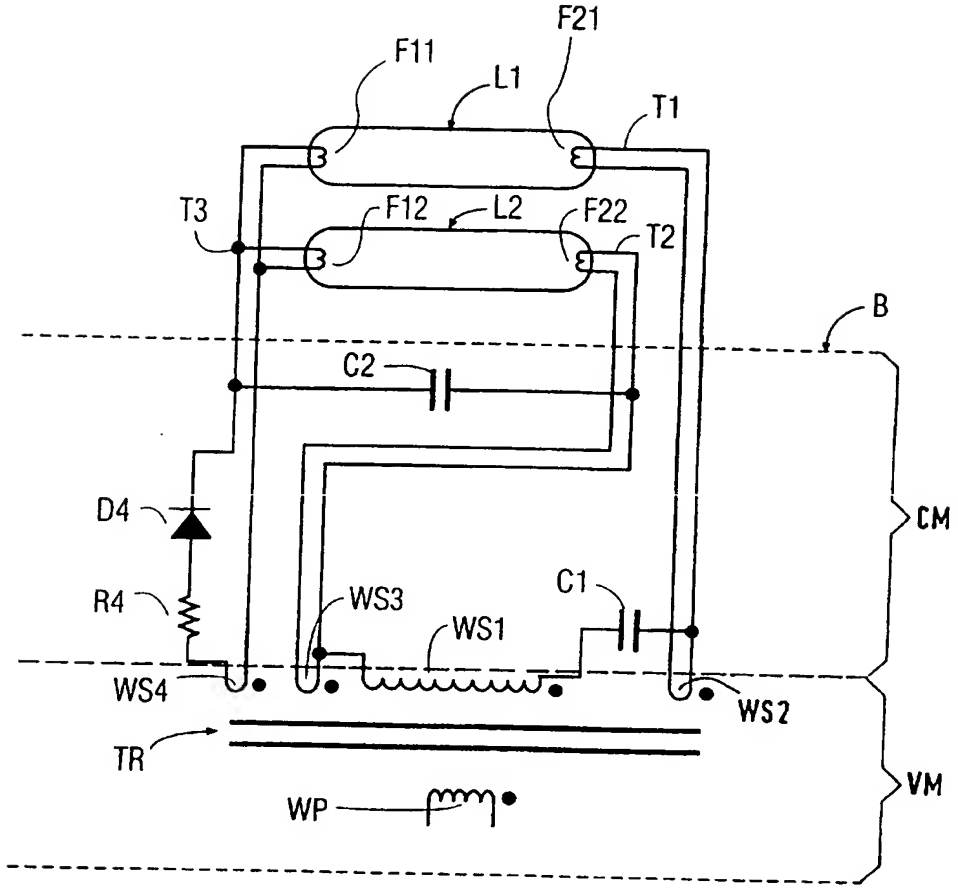
FIG. 3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T1
T3
F12
L2
F22
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B
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D4
CM
R4
WS3
C1
WS1
WS4
WS2
TR
VM
WP

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 97/00908

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H05B 41/29
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, Vol 18,No 382, E-1580 abstract of JP 6-111964 A (TOSHIBA LIGHTING & TECHNOLOGY CORP), 22 April 1994 (22.04.94) --	1-9
X	US 5237243 A (Y-C CHUNG), 17 August 1993 (17.08.93), column 2, line 15 - column 3, line 3, figure 1 --	1-5
X	Patent Abstracts of Japan, Vol 15,No 408, E-1123 abstract of JP 3-167798 A (MATSUSHITA ELECTRIC WORKS LTD), 19 July 1991 (19.07.91) -- --------	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5237243 A	17/08/93	NONE	